Weather Forecasting Capabilities of IMD & Preparedness for SW Monsoon and Cyclones, 2018

भारत मौसम विज्ञान विभाग
India Meteorological Department
Major services of IMD

- Core Services
- Accelerated efforts to improve services
- Support Services

- Aviation
- General Public
- Disaster Support
- Climate
- Shipping
- Agriculture
- Sustainable Urban Development
- Tourism
- Petroleum
- Met. Support For Floods
- Defence
- Satellite
- Non-conventional Energy
- Highways
- Power grid Mgt.
- Environment
Major science themes/applications/services of the organisation

• Prediction of land, atmospheric and Oceanic states at different scales to provide weather and climate forecast in different spatial and temporal range
  – Nowcasting (few hours)
  – Short range (1-2 days)
  – Medium range (few days – week)
  – Extended Range (Week-Month)
  – Seasonal (Few months, e.g. Jun-Sep Monsoon)
  – Climate Scales

Spatial range: Location, Block, District, Meteorological Sub-division, River catchment, State and Homogeneous regionsomo
2-Stage Forecast System for All India (Nation-wide) Season Rainfall

- **1st Stage Forecast**: Based on 5 predictors (SEFS & MMCFS)
  - **April**

- **2nd Stage Forecast**: Based on 6 predictors (SEFS & MMCFS)
  - **June**

**All India June – September Rainfall**

**Update for All India June – September Rainfall**
<table>
<thead>
<tr>
<th>SN</th>
<th>Forecast for</th>
<th>Region for which forecast issued</th>
<th>Issued in</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SW Monsoon Season (June to September) Rainfall</td>
<td>Country as a whole</td>
<td>April/June</td>
</tr>
<tr>
<td>2</td>
<td>South-West Monsoon Onset</td>
<td>Kerala</td>
<td>May</td>
</tr>
<tr>
<td>3</td>
<td>SW Monsoon Season (June to September) Rainfall</td>
<td>Four broad geographical regions: Northwest India, Northeast India, Central India and South Peninsula</td>
<td>June</td>
</tr>
<tr>
<td>4</td>
<td>SW Monsoon Monthly Rainfall for July and August</td>
<td>Country as a whole</td>
<td>June</td>
</tr>
<tr>
<td>5</td>
<td>SW Monsoon Second half of the Season (August- September) Rainfall</td>
<td>Country as a whole</td>
<td>July</td>
</tr>
<tr>
<td>6</td>
<td>September Rainfall</td>
<td>Country as a whole</td>
<td>August</td>
</tr>
</tbody>
</table>
The Monsoon Mission Coupled Forecasting System (MMCFS)

- Original model framework of CFS was developed by the National Centers for Environmental Prediction (NCEP), USA.
- CFS model was further modified to provide better forecasts over the Indian monsoon region through research under the Monsoon Mission.
- Model shows a moderate skill
- The latest high resolution research version of the CFS model was used to generate the forecast for the 2018 SW Monsoon season rainfall using the April initial conditions.
Predictors used in the Statistical Ensemble Forecasting System (SEFS) for the First Stage Forecast of the seasonal rainfall over the country as a whole: 2018

<table>
<thead>
<tr>
<th>S.N</th>
<th>Predictor</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SST Gradient Between Northeast Pacific and Northwest Atlantic (December +January)</td>
<td>December +January</td>
</tr>
<tr>
<td>2</td>
<td>Equatorial SE Indian Ocean Sea Surface Temperature</td>
<td>February + March</td>
</tr>
<tr>
<td>3</td>
<td>East Asia Mean Sea Level Pressure</td>
<td>February + March</td>
</tr>
<tr>
<td>4</td>
<td>NW Europe Land Surface Air Temperatures</td>
<td>January</td>
</tr>
<tr>
<td>5</td>
<td>Equatorial Pacific Warm Water Volume</td>
<td>February + March</td>
</tr>
</tbody>
</table>
ENS0, IOD & Indian Monsoon

➢ El Nino (La Nina) is an abnormal condition over the equatorial Pacific Ocean with the warming (cooling) over the central and east Pacific. In a typical El Nino/La Nina event, warming/cooling of SSTs generally starts around the spring season of a year and peaks in the subsequent winter season. An El Nino/La Nina event develops once in 2-5 year time scale. An El Nino (La Nina) is generally associated with weaker (stronger) than normal monsoon. However, there is no one to one relationship between La Nina/ El Nino and Indian monsoon.

➢ The Indian Ocean Dipole (IOD) event is a climate event occurring over the equatorial Indian Ocean. A positive (negative) dipole event is associated with warming (cooling) over the west Indian Ocean and Cooling (warming) over the east Indian Ocean. This event discovered in late 1990s is not that frequent unlike El Nino/La Nina. Positive (negative) dipole event tends to associate with stronger (weaker) than normal monsoon. However, the relationship between IOD and Indian monsoon is not that strong compared to the relationship between El Nino and Indian Monsoon.
Operational Forecast For 2018 Southwest Monsoon Season Rainfall Over India

Forecast Based on the Operational Statistical Ensemble Forecasting System (SEFS)

❖ Quantitatively, the monsoon seasonal rainfall is likely to be 97% of the Long Period Average (LPA) with a model error of ± 5%.
❖ The 5 category probability forecasts for the Seasonal (June to September) rainfall over the country as a whole is given below:

<table>
<thead>
<tr>
<th>Category</th>
<th>Rainfall Range (% of LPA)</th>
<th>Forecast Probability (%)</th>
<th>Climatological Probability (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deficient</td>
<td>&lt; 90</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>Below Normal</td>
<td>90 - 96</td>
<td>30</td>
<td>17</td>
</tr>
<tr>
<td>Normal</td>
<td>96 - 104</td>
<td>42</td>
<td>33</td>
</tr>
<tr>
<td>Above Normal</td>
<td>104 - 110</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>Excess</td>
<td>&gt; 110</td>
<td>02</td>
<td>17</td>
</tr>
</tbody>
</table>

Forecast suggests maximum probability for normal rainfall and a low probability for deficient rainfall during the season.

Forecast based on the Monsoon Mission Coupled Forecasting System (MMCFS)

❖ The forecast based on the MMCFS (April IC) suggests that the monsoon rainfall during the 2018 monsoon season (June to September) averaged over the country as a whole is likely to be 99% ± 5% of the Long Period Average (LPA).
### PCR model for the Forecasting date of Monsoon onset over Kerala

<table>
<thead>
<tr>
<th>No</th>
<th>Name of Predictor</th>
<th>Period</th>
<th>C.C (1975-2000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Zonal Wind at 200hpa over Indonesian region</td>
<td>16th - 30th Apr</td>
<td>0.48</td>
</tr>
<tr>
<td>2</td>
<td>OLR Over South China Sea</td>
<td>16th - 30th Apr</td>
<td>0.40</td>
</tr>
<tr>
<td>3</td>
<td>Pre-Monsoon Rainfall Peak Date</td>
<td>Pre-monsoon April-May</td>
<td>0.48</td>
</tr>
<tr>
<td>4</td>
<td>Minimum Surface air Tem. over NW India</td>
<td>1st - 15th May</td>
<td>-0.37</td>
</tr>
<tr>
<td>5</td>
<td>Zonal Wind at 925hpa over Equatorial South Indian Ocean</td>
<td>1st - 15th May</td>
<td>0.52</td>
</tr>
<tr>
<td>6</td>
<td>OLR Over Southwest Pacific</td>
<td>1st - 15th May</td>
<td>-0.53</td>
</tr>
</tbody>
</table>

The forecast issued for the 2017 monsoon onset over Kerala was within the forecast limits.
Customized Rainfall Information System (CRIS) developed based on GIS platform includes:

- Preparation of operational real time rainfall maps, graphs and statistics (Daily ~130 rainfall products are generated on real time basis)

Real time Hourly cumulative (one day) AWS/ARG rainfall data on Pan India. Useful for real time rainfall information, urban flooding etc.
GIS based dynamic rainfall products on IMD website:
Rainfall products will be made dynamic as per user specific needs using GIS software;

❖ Temporal GIS layers: Daily, Weekly, Monthly, Seasonal, Annual or for any user defined period.
❖ Spatial GIS layers: Blocks/Taluka, districts, meteorological subdivisions, states/UTs, river basins, river sub basins, regions and pan India.
❖ GIS layers for rainfall categories: normal, excess, large excess, deficient, large deficient, no rain
❖ Inter comparison of 1, 3, 6, 9, 12 month

1-year difference
(This year – Last year)
2-year difference
(This year – 2 years ago)
3-year difference
(This year – 3 years ago) and so on
Sub basin wise Dynamical Model Rainfall

OUTPUT PRODUCTS OF WRF

OUTPUT PRODUCTS OF MME

OUTPUT PRODUCTS OF GFS

Hydromet support for Flood Forecasting - ACHIEVEMENTS
False Alarm Rate, Mixing Ratio & Probability of Detection for Heavy Rainfall Warning

Skill Score

Year

2002-05
2003-06
2004-07
2005-08
2006-09
2007-10
2008-11
2009-12
2010-13
2011-14
2012-15
2013-16
2014-17

FAR
MR
POD
South Asia – Regional Flash Flood Guidance System (SAsiaFFGS)

Global Initiative Project for Flash Floods with MoU between various organisations like UN-WMO, HRC, USAID/OFDA, NOAA and regional NMHS (IMD).

Introduction to SAsiaFFG Implementation Background

The South Asia Flash Flood Guidance System

- The primary mission of the South Asia (SAsiaFFG) System is to provide real-time informational guidance products pertaining to the imminence of potential small-scale flash flooding throughout the region of application.

- Ingests real-time satellite and gauge precipitation data on an hourly basis and, on the basis of available spatial databases, produces flash-flood-occurrence diagnostic indices over small basins in the region of interest.

- The diagnostic flash flood guidance index may then be used with nowcasts or forecast rainfall volumes of the appropriate durations to identify the likelihood of flash flooding at the outlet of specific small catchments.

- SAsiaFFG is not a predictive system in itself, rather it is a diagnostic system for flash floods that the forecaster can use with forecasts or nowcasts of precipitation to produce forecasts and ultimately warnings for flash floods.

Two scientists from IMD out of 9 participants from 5 countries had successfully completed the training course on 31st March 2018 at HRC, San Diego, CA, USA.
TYPES OF POTENTIAL DAMAGES ACCOMPANYING TROPICAL CYCLONES

- CYCLONE
- LOCAL TIDES
- LOCAL COASTAL CONFIGURATION
- STORM SURGE
- WIND
- RAIN
- FLOODING OF COASTAL AREAS
- EROSION OF BEACHES
- LOSS OF SOIL FERTILITY FROM SALINE INTRUSIONS
- DAMAGE TO STRUCTURES
- LOSS OF POWER/COMMUNICATION
- INJURIES & LOSS OF LIFE
- DESTRUCTION OF CROPS, VEGETATION, LIVE-STOCK
- CONTAMINATION OF WATER SUPPLY SYSTEM
- LAND SUBSIDENCE
- FLOODING OF INLAND AREA
## Classification of Low pressure Systems over the NIO since 2015

<table>
<thead>
<tr>
<th>Low pressure system</th>
<th>T Number</th>
<th>Maximum sustained surface wind speed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>knots</td>
</tr>
<tr>
<td>Low (L)</td>
<td>T 1.0</td>
<td>&lt; 17</td>
</tr>
<tr>
<td>Depression (D)</td>
<td>T 1.5</td>
<td>17-27</td>
</tr>
<tr>
<td>Deep depression</td>
<td>T 2.0</td>
<td>28-33</td>
</tr>
<tr>
<td>Cyclonic storm</td>
<td>T 2.5-3.0</td>
<td>34-47</td>
</tr>
<tr>
<td>Severe cyclonic storm</td>
<td>T 3.5</td>
<td>48-63</td>
</tr>
<tr>
<td>Very Severe cyclonic storm</td>
<td>T 4.0-4.5</td>
<td>64-89</td>
</tr>
<tr>
<td>Extremely Severe CyclonicStorm</td>
<td>T 5.0-6.0</td>
<td>90-119</td>
</tr>
<tr>
<td>Super Cyclonic Storm</td>
<td>T 6.5 -8.0</td>
<td>120 and above</td>
</tr>
</tbody>
</table>
Responsibilities of IMD for cyclone Management

1) Nodal agency at National Level

2) Acts as WMO’s Regional Specialised Meteorological Centre for advisories to WMO/ESCAP Panel countries

3) Acts as Tropical Cyclone Advisory Centre (TCAC) for Asia-Pacific and Middle East.

4) Round the clock watch over the entire North Indian Ocean, running of NWP model and issue of warning and advisories.

5) Implementation of the Regional Cyclone Operational Plan of WMO/ESCAP Panel.
Cyclone Monitoring, Forecasting and Warning Services

- **Cyclone Monitoring**
  - Genesis, Location, Intensity (wind, pressure), Structure, size
  - Adverse weather (rainfall, storm surge, inundation)

- **Cyclone Prediction**
  - Location/Track, Intensity, structure/size
  - Adverse weather (Heavy rain, Gale wind, storm Surge, inundation, sea state)

- **Warning Bulletins** (National/international, user and sector specific, impact based)
- **Warning dissemination** (Redundancy, last mile, disaster managers, Press/media, all stake holders)
Monitoring and Forecast Process of Tropical Cyclone

- Monitoring and Forecast Process

**Initial conditions (Observations)**

- Runs of different Models,
- Consecutive runs from the same model,
- Ensemble runs ("choosing the best member")

**Model runs**

**Forecaster**

**Decision maker**

**End forecast**

**Numerical forecasts**

**Broad Classification of Observations**

- **Surface**
  - AWS
  - ARG
  - SYNOP
  - BUOYS
  - AVIATION
  - SHIPS

- **Upper Air**
  - Pilot Balloon
  - RSRW
  - Profiler
  - Ground Based RADAR
  - Aircraft

- **Space Based**
  - Geostationary Satellites
  - Polar Orbiting Satellites
Advances in Cyclone forecasting is achieved through Science and Technological upgradation resulting in:

1. Improvement in observational network
   - High wind speed recorders-21, DWR : 27 (24 IMD+ 3 others)
   - INSAT-3D based satellite derived products
   - INSAT-3D(R), SCATSAT

2. Improved Numerical modelling capabilities (HWRF coupled model was run in case of Ockhi every 6 hourly with 2 km resolution)

3. Fast warning dissemination (SMS to disaster managers, fishermen, farmers and registered general public), NAVTEX, GAMES, CAP

4. Capacity building through Research and Development, Training, and National and international collaboration
Disastrous weather forecasting:

- Storm Surge prediction and Coastal Inundation modeling
  - Implemented in 2013 in collaboration with INCOIS for Indian coast

- Strong wind
  - Operationalisation of coupled HWRF by IMD and INCOIS

- Heavy rainfall
  Numerical Weather Prediction Models
  GFS (12 km resolution)
  GEFS (12 km resolution) to be implemented this year
  Cyclone Specific model (HWRF) implemented
Five Year Moving Average- Track Forecast Error & Skill

Average error in km (2013-17)

<table>
<thead>
<tr>
<th>Lead</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 hr</td>
<td>57.2 km</td>
</tr>
<tr>
<td>36 hr</td>
<td>114.4 km</td>
</tr>
<tr>
<td>60 hr</td>
<td>173.4 km</td>
</tr>
</tbody>
</table>

Reduction in error from 2008-12 to 2013-17:

<table>
<thead>
<tr>
<th>Lead</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 hr</td>
<td>24%</td>
</tr>
<tr>
<td>36 hr</td>
<td>40%</td>
</tr>
<tr>
<td>60 hr</td>
<td>44%</td>
</tr>
</tbody>
</table>

Average during last five years (2013-17)

<table>
<thead>
<tr>
<th>Lead</th>
<th>Skill</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 hr</td>
<td>44.7%</td>
</tr>
<tr>
<td>36 hr</td>
<td>64.5%</td>
</tr>
<tr>
<td>60 hr</td>
<td>70.5%</td>
</tr>
</tbody>
</table>

Improvement in skill from 2008-12 to 2013-17

<table>
<thead>
<tr>
<th>Lead</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 hr</td>
<td>25%</td>
</tr>
<tr>
<td>36 hr</td>
<td>33%</td>
</tr>
<tr>
<td>60 hr</td>
<td>24%</td>
</tr>
</tbody>
</table>
Comparison of tropical cyclone forecast error over NIO, NW Pacific and North Atlantic Ocean

<table>
<thead>
<tr>
<th>Cyclone Forecast error</th>
<th>Lead period of forecast</th>
<th>IMD, New Delhi</th>
<th>NHC, USA</th>
<th>JMA, Tokyo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyclone Track forecast error(km)</td>
<td>24</td>
<td>97.2</td>
<td>73.6</td>
<td>89.8</td>
</tr>
<tr>
<td></td>
<td>48</td>
<td>149.8</td>
<td>131.6</td>
<td>157.4</td>
</tr>
<tr>
<td></td>
<td>72</td>
<td>202.8</td>
<td>190.5</td>
<td>239.8</td>
</tr>
<tr>
<td></td>
<td>96</td>
<td>259.9</td>
<td>275.1</td>
<td>337.0</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td>316.4</td>
<td>363.2</td>
<td>456.8</td>
</tr>
<tr>
<td>Cyclone intensity (wind) forecast error (knots)</td>
<td>24</td>
<td>10.7</td>
<td>7.8</td>
<td>12.2</td>
</tr>
<tr>
<td></td>
<td>48</td>
<td>15.5</td>
<td>11.3</td>
<td>17.1</td>
</tr>
<tr>
<td></td>
<td>72</td>
<td>16.3</td>
<td>12.6</td>
<td>19.8</td>
</tr>
</tbody>
</table>
Cyclone Bulletins

- Bulletin for India coast
- Tropical weather outlook: Once a day based on 0300 UTC observation
- Special Tropical Weather Outlook: Twice a day based on 0300 and 1200 UTC observation during depression stage
- Tropical Cyclone Advisories: Every three hourly during cyclone period
- Tropical Cyclone Advisories for Aviation as per the guidelines of ICAO every six hourly during cyclone period
- Quadrant winds (Structure Forecast)
BULLETINS AND WARNINGS ISSUED BY ACWCS AND CWCS

- Four stage cyclone warning
  - Sea area bulletin
  - Coastal weather bulletin
  - Bulletins for Indian navy
  - Fisheries warnings
  - Port warnings
  - Aviation warning
  - Bulletins for departmental exchanges
  - Bulletins for AIR/ Doordarshan/ press
  - Warnings for registered/ designated users.

- Pre-cyclone watch – Issued at least 72 hrs in advance indicating formation of a cyclonic disturbance – potential to intensify into a Cyclone and coastal belt to be affected.
- Cyclone Alert – Issued at least 48 hrs in advance indicating expected adverse weather conditions.
- Cyclone warning – Issued at least 24 hrs in advance indicating latest position of Tropical Cyclone, intensity, time and point of landfall, storm surge height, type of damages expected and actions suggested.
- Post-Landfall Outlook – Issued about 12 hrs before landfall & till cyclone force winds prevail; District Collectors of interior districts besides the coastal areas are also informed.
- Finally a ‘De-Warning’ message is issued when the Tropical Cyclone weakens or have no adverse impact.
Advances in Warning Dissemination Mechanism

- Telephone, Tele-fax
- Mobile Phones (SMS) through IMD severe weather network, Agromet Network, INCOIS network.
- VHF/HFRT/Police Wireless
- Satellite based cyclone warning dissemination System
- Aeronautical Fixed Terminal Network
- Global telecommunication system (GTS) : (International Telecom centres)
- NAVTEX
- Internet (e-mail), ftp
- Dedicated website for cyclone (rsmcnewdelhi.imd.gov.in)
- Radio/TV, News Paper network (AM, FM, Commmunity Radio, Private TV) : Prasar Bharati and private broadcasters
- NAVIK and GAMES to be attempted
New initiatives in 2018

- Special bulletin to DM authorities from the stage of low pressure area stage, if it is expected to intensify and affect any state (implemented from March 2018 depression)
- Tropical weather outlook extended from 3 days to five days validity period
- Objective track and intensity forecast from the stage of depression in stead of earlier deep depression stage
- Biweekly outlook on cyclogenesis introduced from 22 April 2018
- Special Ocean-atmosphere coupled model for cyclone prediction
- Ensemble forecast system (12 km resolution) to be implemented
- Fishermen Awareness workshop conducted for coastal states to get feedback for improvement
- Media workshop will be conducted regularly at state levels
- Bulletins will be issued to religious institution for mass communication
- Common alert protocol being introduced in collaboration with NDMA
- Warning communication to deep sea through NAVIK and GAGAN messaging system
**Pre-cyclone Exercise:**

1. Computer and Telefax machines

2. Tele-Communications

3. **Police W/T:** Any action required in connection with the issue of warnings through Police W/T is completed.

4. **Publicity and Broadcast of Warnings**

5. **Observational data and Organisation**

6. **Reference publications (SOP, Manual, handbook etc) and forms**

7. **Circular letter to warnees (Warnees to listen to AIR, Action taken by warnees**

8. **Circular letter to Chief Secretaries**

9. **Circular letter to the Port Officers**

10. **Meeting with the Chief Secretaries of the Maritime States ACWCs/CWCs/MCs connected with storm warning work:**
Weather Services – Targets 2018

- Station level nowcasts to be extended to all district headquarters and tourism sites coming under the range of DWRs.
- Warnings Dissemination through GAMES & NAVIC
- Support for the Common Alert Protocol programme of NDMA
- Extending Fog guidance for Indian Railways
- Extension of heat action plan to all important cities
- Familiarization Training workshop for the elected representatives like MLAs & MPs of the country
Four (04) X-Band DWRs planned to be installed in J&K state at Leh, Gulmarg, Baltal and Jammu.
Three (03) X-Band DWRs planned to be installed in HP at Bhunter, Dalhousie and Shimla.
Three (03) X-Band DWRs planned to be installed in Uttarakhand State at Mussoorie, Nainital and Uttarkashi.

11 C Band Radars are planned to be commissioned at the following places.

<table>
<thead>
<tr>
<th>Sriganganagar</th>
<th>Ahmedabad</th>
<th>Mumbai</th>
<th>Ratnagiri</th>
<th>Mangalore</th>
<th>Lakshadweep</th>
<th>Bangalore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anantpur</td>
<td>Sambalpur</td>
<td>Ranchi</td>
<td>Port Blair</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Numerical Weather Prediction (NWP) Modeling: Backbone for Forecasting and Warning Services

Models in 2018:
- **Ensemble Pred. Tools**
  - GEFS(1534/574), UMEPS
- **Global Models**
  - GFS(T1534/574), Unified Model
- **Regional Models**
  - WRF, HWRF
- **Nowcasting Tools**
  - (WDSSII, ARPS Model)

Warnings Activities

- Multi-model ensemble, Single Model Ensemble, Grand Global Ensemble
- Global models
- Regional models
- Nowcasting

❖ By 2019: 1-3 km Regional multi-model prediction system, ocean-atmosphere coupled severe weather pred. systems, Parametric models and Expert systems – severe weather Warning up to 5-7 days, Forecast outlook up to 10-15 days.
Regular Weather Charts

- IMD MESOSCALE MODEL (03 Km) 850 hPa FORECAST (24 hr)
  Height(m), Wind (Kt) & Isotach based on 00 UTC of 03-04-2018 valid for 00 UTC of 04-04-2018

- IMD MESOSCALE MODEL (03 Km) 24 HOURLY RAINFALL (mm) FORECAST (48 hr)
  based on 00 UTC of 03-04-2018 valid for 03 UTC of 05-04-2018

- IMD MESOSCALE MODEL (09 Km) FORECAST (9 hr)
  Maximum Reflectivity based on 00 UTC of 03-04-2018 valid for 09 UTC of 03-04-2018
Operational Nowcasting

➢ 399 stations covered so far in May 2018
➢ Nowcasting for district level since 2017
➢ Nowcast Page is updated by Meteorological Centres
➢ Nowcast bulletins by SMS issued for severe weather for district level and transmitted through SMS and e-mail
➢ Enhanced DWR network by 2019 with IMD and IAF network covering entire country
➢ Target: location specific nowcast for 660 stations by 2019
Multi-Hazard Early Warning System and Common Alert Protocol

- **Existing multi-hazard EWS is based on colour code with limited impact based forecast**

  - | Potential impacts |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
</tr>
<tr>
<td>Medium</td>
</tr>
<tr>
<td>Low</td>
</tr>
<tr>
<td>Very Low</td>
</tr>
</tbody>
</table>

- **Opportunity:** MHEWS for Chennai under consideration in collaboration with NCCR
- DSS for MHEWS for cyclone: RFP is under preparation
- CAP being developed for all severe weather by NDMA in collaboration with IMD
New Sectoral Application: Heat Wave

- Seasonal and extended range (upto two weeks) outlook
- District level heat wave warning (upto five days)
- Heat action plan with different states
- Heat action plan for cities

3.3 Identification of Color Signals for Heat Alert³:

<table>
<thead>
<tr>
<th>Color Alert (Condition)</th>
<th>Extreme Heat Alert for the Day</th>
<th>Normal Maximum Temp Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Alert (Severe Condition)</td>
<td>Extreme Heat Alert for the Day</td>
<td>Normal Maximum Temp Increase 6°C to more</td>
</tr>
<tr>
<td>Orange Alert (Moderate Condition)</td>
<td>Heat Alert Day</td>
<td>Normal Maximum Temp Increase 4°C to 5°C</td>
</tr>
<tr>
<td>Yellow Alert (Heat Wave Warning)</td>
<td>Hot Day</td>
<td>Nearby Normal Maximum Temp</td>
</tr>
<tr>
<td>White (Normal)</td>
<td>Normal Day</td>
<td>Below Normal Maximum Temp</td>
</tr>
</tbody>
</table>

IMD jointly received “Awards for Excellence in Climate Change Mitigation & Adaptation” under the category “Leadership in Urban Climate Action” on 17th April 2018 at New Delhi for the development & implementation of Heat Action Plan in the country for the city of Ahmedabad contributing to the UN sustainable development Goal on Climate Action.

Ahmedabad Heat Action Plan
Tourism Forecast Services

- **438** Tourists Sites from **21** States/UTs in coordination with State Authorities and other stakeholders identified for developing tourism forecast application.

- Online survey for prioritizing for states and Tourist sites as per Tourist inflow is completed. (Domestic/International).

- Liaisoning with State Govt. / Tourist Dept. for on the site support (Security, Electricity, Network, Space for Display systems and AWS) is being pursued.

- Technical consultancy initiated for developing proof of concept for mobile app, Module for Display Screens and Website for Tourist forecast.

- In collaboration with Map my India on customizing Tourist Information for Shri Char Dham Yatra and Shri Amarnath Ji Yatra, API’s for sharing weather data and Radar and Satellite images already developed in-house and shared.

- The app is built on IBM’s enterprise mobility platform is customized for tourism forecast.
Collaboration with MapmyIndia on customizing tourist Information for Shri Char Dham Yatra, Shri Amarnath Ji Yatra and other Yatras (current wx and forecast, nowcasts)

Flow diagram of Network

- **Central Sever at HQ**
- **Earth Station**
- **GSM Modem** (for Plain Stations)
- **AWS station**
- **NWP**
- **RMC/MC** (Value added Fc (NOWCAST, SRF, MRF))
- **Extended Range Fc**

- **Web Port**
- **Display**
- **TV, Email, Newspaper, FM etc**
- **Air Quality SAFAR**
- **Info CRS, Pune**

( API’s for sharing weather data and Radar and Satellite images already developed in-house)
Thank You